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ABSTRACT

This report addresses the barriers college students with disabilities face in the laboratory setting. In engineering, mathematics, and science education most courses require laboratory work which may pose challenges to those with disabilities. Instructors should be aware of the individual needs of students with disabilities and make necessary accommodations. The legal requirements on accessibility are reviewed in both the Rehabilitation Act of 1973 and the Americans with Disabilities Act. Services for students with disabilities that may be available at postsecondary institutions are explained. The characteristics that should be considered for the design of innovative tools or for modifying existing equipment in the laboratory settings are examined. Factors are highlighted that should be considered before the modification of laboratories. The design and production of a disability-accessible Computer Assisted Design/Computer Assisted Mathematics station are described and illustrated. An appendix lists 25 sites on the World Wide Web for helping students with disabilities in the areas of science, mathematics, and engineering. A second appendix lists 12 assistive technology sources. (CR)

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Laboratory Barriers in Science, Engineering, and Mathematics for Students with Disabilities

**The Study Conducted Under the Grant From the Regional Alliance for Science, Engineering, and Mathematics (RASEM)
New Mexico State University**

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Laboratory Barriers in Science, Engineering, and Mathematics for Students with Disabilities

Overview

Most of the courses related to science, engineering, and mathematics require one or more credit hours of laboratory work. Students with disabilities face numerous barriers in completing the laboratory requirement of these fields. The instructors should be aware of the individual needs of students with a disability, and be able to create an accommodating environment in the laboratory.

According to their individual disability, students with disabilities require special accommodations in the laboratory setting. The student and instructor should determine together what modifications are necessary. More ideas can be obtained by consulting with students with disabilities who have gone through the laboratory experience before (AAAS, 1991). Most barriers can be overcome with care and input from students.

The instructor and the student need to work as a team. The student knows his or her needs, as well as solutions that have been effective in the past. The instructor knows what steps are needed for successful completion of the laboratory experiment. As a team they can identify potential problems and strategies to overcome the barriers (AAAS, 1991). Appendix A provides a list of web sites for helping students with disabilities in the areas of science, mathematics and engineering.

A barrier free laboratory is one that is fully accessible to

a disabled student. A barrier free laboratory should have an accessible building for students with mobility impairments and revised laboratory and safety equipment to accommodate a student with a disability (Flick, 1992).

The instructor can make substantial contributions to the education of students with disabilities by designing new tools or modifying the existing equipment to accommodate their needs. In order to assist these students, it is helpful to understand several major concerns that these students face (DRES, 1996).

Time:

To accommodate their disabilities, students usually need to spend more time on laboratory experiments. They often rely on time consuming learning methods which may involve special settings, modified equipment, and assistance from a laboratory-aid.

Access:

Inaccessible or partly accessible laboratories are a problem. Laboratories are often crowded and difficult to move around in.

Changes:

To meet their responsibilities, students with disabilities must schedule their activities far in advance. Last minute changes in projects and or assignments can severely interrupt their plans.

The Law and the Students with Disabilities

In 1973, Congress passed the Rehabilitation Act (Public Law 93-112). This Act guarantees civil rights for Americans with disabilities. It is grounded in the due process clause of the Fifth Amendment and the equal protection clause of the Fourteenth

Amendment. Section 504 is that section of the law that specifically refers to post-secondary and vocational education services. The Americans with Disabilities Act (ADA) was passed in 1990 and simply reaffirms the 1973 Rehabilitation Act by prohibiting discrimination in four essential areas: employment, public service, public accommodations, and telecommunication relay services.

The Rehabilitation Act provides that "...no otherwise qualified handicapped individual in the United States shall, solely by reason of handicap, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." With respect to post secondary and vocational educational services, "otherwise qualified" means a person with a disability who meets the academic and technical standards requisite to admission or participation in the program or activity.

The ADA has four articulated purposes:

1. To provide a national mandate for the elimination of discrimination against individuals with disabilities.
2. To provide enforceable standards addressing that discrimination.
3. To ensure that the federal government plays a central role in enforcing the standards.
4. To invoke the sweep of congressional authority in order to address the major areas of that discrimination.

Services for Students with Disabilities at Post-secondary Institutions

The Office of Services to Students with Disabilities (SSD) is a part of the Student Academic Services. Its mission is to assist student who may have one or more disabilities in their adjustment to post-secondary education. The Office of Services to Students with Disabilities provides a variety of services designed to nurture independence and success for disabled students. These services may include but are not limited to the following:

1. Text enlargement devices for the partially-sighted.
2. Talking computers for partially and non-sighted individuals and for individuals who may have learning disabilities, which includes the capability to scan and read aloud texts and other print material.
3. Taped texts for partially and non-sighted and learning disabled students.
4. Texts in braille.
5. Note-takers for students with mobility impairments.
6. Special arrangements for testing including extended, proctored tests, distraction-free environments, and test reading.
7. Typing services.
8. Referral for students wishing to be tested for learning disabilities.
9. Campus and community orientation.
10. Services for Students with Disabilities provides consulting for any faculty member who wishes to provide accommodation to students who have disabilities.

Design and Modification of Equipment and Tools

The work and living environment is not designed or built

with disabled people in mind (Brightman, 1995). The challenge is to educate the designers, in this case the instructor about the needs of students with disabilities who are typically ignored in the generic design process.

The following characteristics should be considered for the design of innovative tools or modifying the existing equipment in the laboratory settings for the use of a students with disabilities (Ward, 1990):

1. Evaluating existing structure.
2. Project cost.
3. Maintenance and reliability.
4. The size, dimension, location, appearance, and controls.
5. Simple and easy to follow features.
6. Safety features.

The following factors should be considered before the modification of laboratories for the use of students with disabilities:

1. Accessibility to the laboratory.
2. Evaluating the essential function of the laboratory activity and the students' abilities.
3. Incorporating student's capability into an effective laboratory experiment.
4. Design new, or modify existing tools and equipment to increase student's productivity in the laboratory.
5. Apply the American National Standards Institute (ANSI) standards to the new designs.
6. Use the American with Disability Act (ADA) information.

Assistive Technology

Assistive technology is the design, modification, and production of a tool, product, or equipment which assists, improves, or increases performance of a person with a disability (ATS, 1996). The Technology-Related Assistance for Individuals with Disabilities Act of 1988, describes the assistive technology as follows:

> "Assistive Technology devices can be anything from a simple tool with no moving parts (e.g., a toothbrush with a built-up handle) to a sophisticated mechanical/electronic system (e.g., a robotic arm). Simple, mechanical devices are often referred to as low tech devices while computer-driven or complex assistive technology may be called high tech. However, many people in the assistive technology field have argued that this complexity-base classification is not a useful one as there is no clear division between simple or low tech and complex or high tech devices. With the passage of the Rehabilitation Act Amendments of 1992 (PL 102-569), assistive technology devices and assistive technology services are now included as part of rehabilitation technology."

There are a variety of agencies and universities which provide research findings or support for assistive technologies. A list of such organizations are listed in Appendix B.

Design and Production of A Handicap Accessible CAD/CAM Station

A handicap accessible CAD/CAM work station was designed at the Technology Department of Eastern New Mexico University under a grant from the Regional Alliance for Science, Engineering, and Mathematics (RASEM). A review of literature suggested the following dimensions for the design of the work station: Work surface no higher than 30 inches from the floor. Cleared space under work surfaces of 36 inches wide, and at least 20 inches

deep. A wooden working model was built using the above dimensions.

A student with mobility impairment was selected and trained to use the handicap accessible CAD/CAM work station. The student's input and suggestions were collected and implemented to modify the working model. A final handicap accessible CAD/CAM work station was designed and built using square metal tubing and sheet metal. The bill of materials and detail blueprint are as follows:

Bill of Materials

120 feet of square tubing

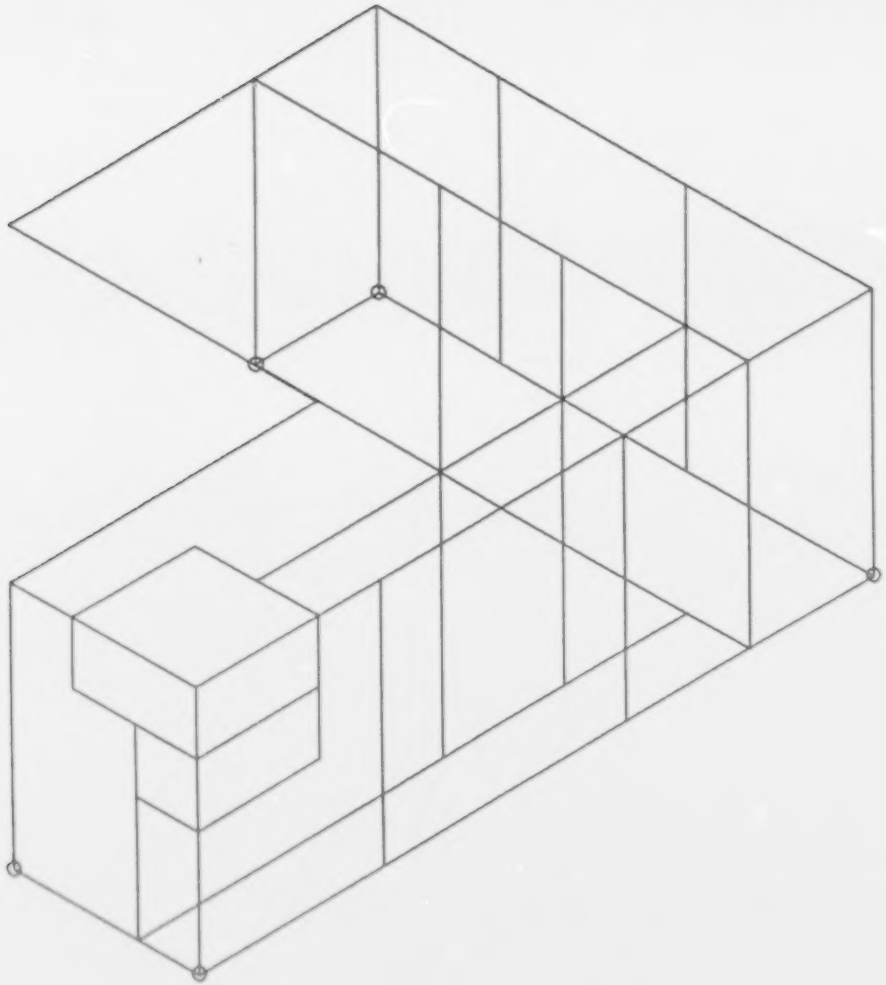
2 sheets of 4X8 10 gage sheet metal

welding rods and supplies

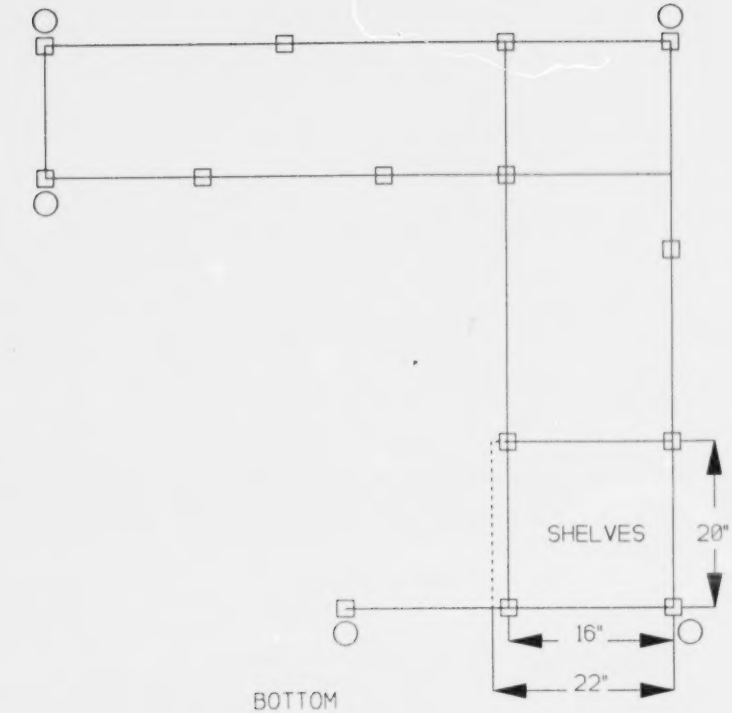
paint and primer

five 3" casters

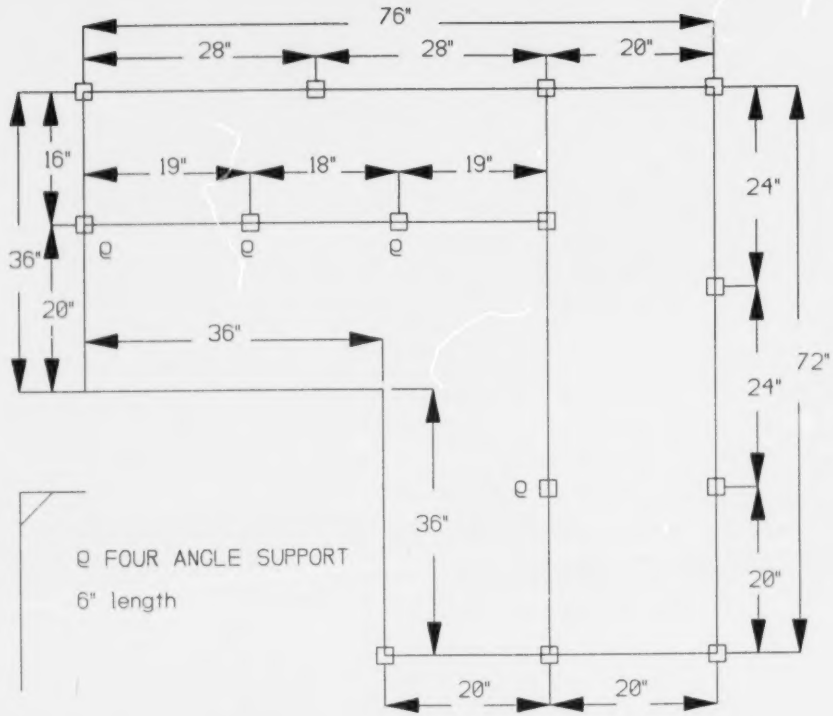
2 feet of 1/4 X 3 Flat sheet metal



HANDICAP ACCESSIBLE CAD/CAM WORKSTATION

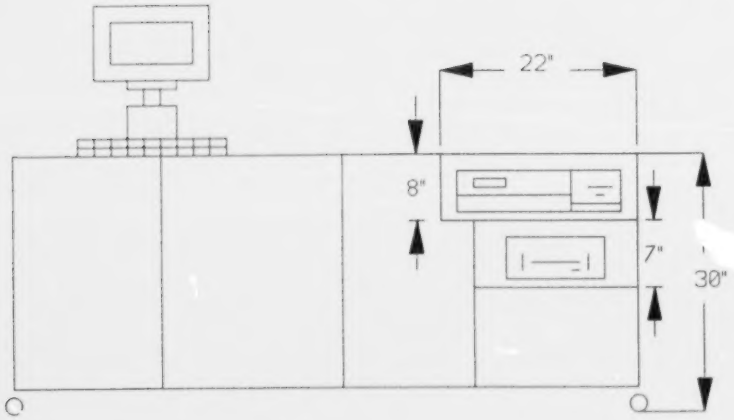


BOTTOM



℄ FOUR ANGLE SUPPORT
6" length

TOP



FRONT

HANDICAP ACCESSIBLE CAD/CAM STATION

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(ERIC Document Reproduction Service No. ED 373 997)

Flick, H. (1992). Disability Accommodation Handbook. Kansas City, MO: Metropolitan Community Colleges.
(ERIC Document Reproduction Service No. ED 358 880)

Ward, C. (1990). Design for All: Consumer Needs Assessment Project Year 2. Result of the Second Year of a Five Year Study. Washington, D.C. Rehabilitation Engineering Center.
(ERIC Document Reproduction Service No. ED 348 831)

Assistive Technology Services (ATS), (1996). Assistive Technology. http://www.asel.udel.edu/at-onl

Brightman, A. (1996). Challenging the Myth of Disability.
gopher://gopher.oise.o...ties/myths-of-disability

The Division of Rehabilitation Education Services (DRES), (1996). Teaching Students with Disabilities.
gopher://gopher.uiuc.edu/oo/dis

APPENDIX A

Sites on the Web for Helping Students with Disabilities in the Areas of Science Mathematics and Engineering

Free Mac Programs which Assist People with Disabilities
Http://www.sped.ukans.edu/-dlance/freeindex.html

Cheap Mac Shareware for People with Disabilities
Http://www.sped.ukans.edu/-dlance/cheap.html

Center on Information Technology Accommodations
Http://www.gsa.gov/cocamain.html

Captioning Technologies
Http://www.gsa.gov/coca/captioning.html

Hunter-Joyce-Inc.
Http://www.hj.com/

Telesensory
Http://www.telesensory.com/indextxt.htm

University of Delaware
A.I. Dupont Institute Center for Applied Science and Engineering
1600 Rockland Rd.
P.O. Box 269
Wilminston, D.E. 19899
Foulds@asel.udel.edu
Richard A. Foulds, Ph.D
Ph# 302-651-6830
Donna Bacon, Education and Training, Coordinator
Ph# 302-651-6830

Bibliography on Assistive Technology
Ftp://ftp.bc.gov/pub/nls/reference/biblio/assistive/bib

Assistive Technology for the Disabled Computer User
Http://www.lat.unc.edu/guides/irg-zo.html

Converting Science and Math into Braille
gopher://sjuvm.stjohns.edu:70/00/disabled/easi/easilib/easilib/op po4

Easisem
gopher://sjuvm.stjohns.edu:70/11/disabled/easi/easisem

Free and Cheap Windows Software for People with Disabilities
Http://www.sped.ukans.edu/-dlance/windows.html
Http://www.infi.net/-thobbs/shareware.html

Science Accessibility Project: Oregon State University
Http://dots.physics.orst.edu/
Software Available
Dots Plus: Used for printing technical material

G.S. Braille: Dual 6/8 dot uniform braille code
Aster: Computer system created to read scientific and technical manuals using a voice synthesizer
Triangle: Mathematics scratchpad for the blind

Assistive Technology for the Disabled Computer User
Ftp://129.71.67.30/education/fs_compu.txt.

New Software for the Disabled Users
Http://toolbox.rutgers.edu/nbcs/newsletter/rn56/portney.html

Easi
Http://www.rit.edu./ easi/easisem.html

Accessing Mathematics, Graphics and 3-D Models
Http://www.rit.edu./-easi/easisem/mathgrph.html

Do-It at the University of Washington
Http://weber.u.washington.edu:80/-doit/

American Association for the Advancement of Science
1333 H Street. NW Washington, DC 20005
Voice/TDD: 202-326-6649
Internet: info@aaas.org

Foundations for Science and Disabilities
236 Grant Street
Morgantown, West Virginia 26516-7609
Phone: 304-293-6363

Heath Resource Center
One Dupont Circle, Suite 800
Washington, DC 20036
Voice/TT: 202-9393-9320
Internet: heath@ace.nche.edu

National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
Phone: 202-289-2140
Internet: info@nsf.gov
URL: Http://www.nsf.gov

Recording for the Blind and Dyslexic
Phone: 609-452-0606 or 800-221-4792
Internet: info@rfbd.org

Trace Research and Development
S-151 Waisman Center, 1500 Highland Ave.
Madison, WI 53705
Phone: 608-263-6966
TDD: 608-263-5408
Internet: essers@macc.wisc.edu

APPENDIX B

List of Assistive Technology Sources

Access Research Group's: Develops electric interfaces for people with disabilities.

Archimedes Project: Promotes equal access to information for individuals with disabilities.

AZtech Inc: Provides support for design of assistive technology equipment.

Cambridge University Rehabilitation Engineering Research: Studies the application of robotics technology for the benefit of physically disabled people.

Department of Veteran Affairs at the Palo Alto Rehab R&D: Provides support for disabled veterans in their pursuit of independence living.

Dundee University MicroCenter: Addressing computer needs of persons with disabilities.

Gallaudent Research Institute (GRI): A leader in many areas of research on deafness and the deaf.

Rehabilitation Engineering and Prosthetics Orthotic Center: Develops systems for computer aided engineering of prosthetic limbs.

Trace Research and Development: Improves the accessibility of computers and computer systems to individual with disabilities.

University of Toronto's Adaptive Technology Resource Center's: Develops creative solutions to the challenges faced by users of adaptive technology.

West Virginia Rehabilitation Research and Training Center and the Rehabilitation Information System: Provides a searchable database of research available to the public.

Source: Index of Assistive Technology and Disability Internet Resources.
http://www.edu/at-online/internet/research.html